Comparison of the Meat Quality of Turopolje, German Landrace x Turopolje and German Landrace x Pietrain Pigs

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Summary

Aim of the study was to evaluate, if the mixed breed German Landrace x Turopolje (L x T) was suitable for conventional fattening and the production of high quality palatable meat. Hence, we chose to study the carcass characteristics of three different breeds: true bred Turopolje (T x T) (n=15), an autochthonous Croatian breed, German Landrace x Pietrain (L x P) (n=19), a typical German pig hybrid and German Landrace x Turopolje (L x T) (n=23) as mixed breed. All three breeds were kept in a conventional fattening indoor system. The data consisted of the chemical and physical values of the carcass and the difference between breeds during breeding and fattening. All pigs were fattened with a conventional ad libidum feeding system. The feed consisted of an optimal mixture for the fattening of L x P. The daily feed intake and the weight from birth until the end of the fattening was recorded every 14 days. The quality of the carcass was evaluated at the age of 20 and 25 weeks. The measurement of the carcass was based on the "Richtlinie für die Stationsprüfung auf Mastleistung, Schlachtkörperwert und Fleischbeschaffenheit beim Schwein" published by the national German control office. L x T showed the lowest feed intake per kg carcass compared to the other breeds. The quality of meat was characterized by pH, conductance, intramuscular fat and water holding capacity. L x T showed a trend for a lower conductance in week 25. The value of pH and water holding capacity was not significant between the breeds. Surprisingly, the intramuscular fat of L x T was by trend higher compared to L x P and significantly lower than T x T ($p < 0.05$). L x T had by trend a higher carcass weight and a larger carcass length compared to L x P, which was significantly higher than T x T ($p < 0.05$). In conclusion, the new breed L x T seems to be suitable for an indoor fattening system and produces a high quality palatable meat. The energy and protein intake should be slightly reduced, which would reduce the cost of meat production.

Key words

carcass, intramuscular fat, hybrid pig, Turopolje pig breed

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Introduction

The domestic consumption of pork in Germany increased steadily from 54.2 kg/head in the year 2000 to 55.1 kg/head in the year 2010 (BMLEV, 2010). The production of pork was modified from quality to quantity to cover the increasing demand. As a result, the pork has become dry and tasteless. Changes are currently made to increase the quality of pork concerning certain parameters such as intramuscular fat (IMF), conductance (Seewald et al., 1993), water holding capacity in addition to sensory attributes such as tenderness and juiciness (Edwards, 2005; Fortin et al., 2005). Meat is considered tasty, if the value of IMF is higher than 1.5% (Fortin et al., 2005). The crossing of German Landrace or White Large, respectively, with Pietrain reduced the water holding capacity and the stress resistance (Dudenhoff et al., 2011), but also reduced the value of IMF under 1. % and the tastiness of the pork (Fortin et al., 2005). Therefore emphasis should be put on the increase of palatability and quality of pork for example by cross breeding with old pig races. One of the oldest pig races in Europe is the Turopolje pig. This autochthonous breed was added to the FAO list of endangered and disappearing breeds (Đikić et al., 2008; Loftus, 1993). It originated in Croatia near Zagreb in forest and marsh meadows (Đikić et al., 2010). Turopolje are growing slowly and the body tends to obesity during a conventional mast, because of their optimal adaption to their natural ecosystem (Đikić, 1999). Crossing Turopolje with a modern breed (Swedish Landrace x Hypor) has been reported by Đikić et al. (2008). Other studies have crossed old with modern breeds, such as Large White with Minzhu (Luo et al., 2012), Lithuanian indigenous pigs with wild boar hybrids (Razmaite et al., 2009) or Cinta Sense pigs with Large White (Oreste et al., 2005). All of these studies evaluated the quality of the meat and the carcass.

The aim of the experiment was to evaluate, if the mixed breed German Landrace x Turopolje (L x T) was suitable for a conventional mast and the production of high quality palatable meat. The breeding success, fattening progress and meat quality was compared to the pure bred Turopolje (T x T) and to the modern fattening hybrid German Landrace x Pietrain (L x P).

Materials and methods

Animals

The experiment took place in the Experimental Station Thalhausen, Technische Universität München, Germany. It was approved by the government of Upper Bavaria. Between November 2011 and April 2012 three pig breeds were used in this experiment. Pure bred Turopolje (T x T) was used as a control group; German Landrace was crossed with a Pietrain (L x P) or with Turopolje (L x T).

All Turopolje pigs were loaned by the Tierpark Arche Warder e.V., Germany. They originate from the Austrian subpopulation (Druml et al., 2012). The German Landrace sows were obtained from the Experimental Station Thalhausen. Two different Turopolje boars were used to strengthen the differences between T x T and L x T by a higher variation within the results. One boar was used for the insemination of three German Landrace sows and another for the covering of three Turopolje sows. Three different German Landrace sows were artificially inseminated with semen from the same Pietrain boar. The sows were kept in a herd system with outdoor area and ad libitum feeding with transponder after the positive pregnancy control. One week before birth, the sows was washed and kept in the farrowing pen. The movement of the sows was restricted to prevent squashing of the piglets. The feeding was conducted automatically in the morning and evening. The composition of the feed was the same for each sow, just the daily ration was adjusted depending on the energy requirements of each sow. Each farrowing pen had a piglet pen with temperature of 37°C. The birth weight of all piglets was recorded during the birth monitoring before the first intake of colostrum. All male piglets were castrated and received an analgesic (0.4 mg Meloxicam/kg body weight, Metacam, Boehringer Ingelheim, Ingelheim, Germany) one day after birth. All piglets were injected with iron (2 mg/kg Eisen-Dextran Serumwerk Bernburg AG, Bernburg, Germany). In total 57 piglets were used for the experiment (T x T: n=15; L x T: n=23; L x P: n=19).

Animal experiment

The piglets of all breeds were weaned at four weeks of age and seven to nine piglets of each breed were grouped together in a conventional piglet stall. The flats were equipped with feed dispenser for an ad libidum feeding and nipple drinker. The temperature was kept constant at 23°C. The feed mixture per kilogram constited of 884.00 g dry matter, 186.60 g raw protein, 12.75 g lysine, 33.92 g coarse fiber, 7.658 g calcium, 5.264 g phosphor and 13.28 MJ metabolic energy. All pigs were rehoused after eight weeks in a conventional fattening stable without regrouping. During the fattening period the pigs were weighed every 14 days and fed using an ad libidum feed system. The feed intake was automatically measured by a transponder system (Schauer Technology, Porking, Germany). The feed was mixed at the Experimental Station Thalhausen and consisted of winter barley (own production), winter wheat (own production), soy extraction meal (Bunge, Mannheim, Germany), soy oil (Bunge, Mannheim, Germany) and a mineral and vitamin feed (Schaumann, Pinneberg, Germany). The feed mixture per kilogram consisted of 883.30 g dry matter, 184.90 g raw protein, 11.07 g lysine, 31.55 g coarse fiber, 7.44 g calcium and 4.60 g phosphor and 13.48 MJ metabolic energy from the beginning of the fattening period to 65 kg body weight. From 65 kg body weight to the end of the fattening period the feed mixture had the following ingredients per kilogram: 882.50 g dry matter, 168.00 g raw protein, 9.58 g lysine, 31.35 g coarse fiber, 6.84 g calcium, 4.40 g phosphor and 13.38 MJ metabolic energy. Eight to twelve pigs per breed were slaughtered at the slaughterhouse of the Bavarian State Research Center for Agriculture (Grub, Germany) with 20 weeks of age during the fattening period to evaluate the growth progress. The rest of the pigs were slaughtered after 25 weeks of age.

Data evaluation

All carcass data were scaled according to the regulations of the national control office (ZDS, 2007). Fat and muscle thickness was measured using the Hennessy GP4 probe (Hennessy Grading Systems LTD, Auckland, New Zealand). The lean muscle was calculated in addition using the Bonner-formula (ZDS, 2007). The SEUROP class was also scaled with the same probe. SEUROP is an EU classification system for carcasses. This system applies to carcass weight between 50 kg to 120 kg. Class S classifies the best meat quality with a lean meat percentage above 60%. Carcasses lower then 40% of lean meat are grouped in class P. The pH was measured using pH-Star (Matthäus, Pöttmes, Germany) in the chop 45 min and 24 h post mortem (pH_1-K and pH_{24}-K) and in the ham 24 h post mortem (pH_{24}-S). Before the pH measurement the temperature of the meat was tested. The measuring point of the chop was on the musculus longissimus dorsi (MLD) between the 13th and 14th spinosus processes of the thoracic vertebra. The probe was entered 4 cm into the carcass. The test point in the ham was located 4 - 6 cm above and 2 - 3 cm lateral of the pelvic bone. Furthermore, conductance was measured using the LF-Star (Matthäus, Pöttmes, Germany). The conductance was tested 24 h post mortem between the spinosus processes from 14th and 15th thoracic vertebra in a depth of about 6 cm.

Intramuscular fat (IMF) and water holding capacity were measured by the Bavarian State Research Center for Agriculture, Department Qualitätssicherung und Untersuchungswesen Zentrallabor Grub, Futtermittelanalytik und Qualität tierischer Produkte (Poing, Germany) only on week 25. The samples were homogenised to measure IMF and heated with hydrochloric acid (own production). The liquid was filtered through a filter paper and the filter residue washed to neutrality. The filter residue was dried and then extracted with petroleum ether (own production) for at least 5 h. In the next step the solvent was distilled and the residue dried at 103°C +/- 2°C. At the end the fat content was calculated using the formula: Fat [%] = ((back weight from whole weight - empty weight from cob) x 100) / sample size (LMGB, 1980)

The water holding capacity was measured according to the absorption spectrum in the near infra-red spectral region (NIRSystem6500, Foss, Hamburg, Germany).

Furthermore, the areas of fat above the muscle longissimus dorsi and the area of the muscle itself were analyzed. The procedure was carried out according to Landesprüfanstalt (LPA) regulations (ZDS, 2007). The chop was cutted on the hanging carcass vertically to the spinal column between the 13th and 14th thoracic vertebra. The chop was photographed using a special stand with a measurement scale and reproduced 1:1. The scale was placed as close as possible to the chop. The measurement was conducted with a planimeter. The fat was measured from the same chomp as the muscle area according to the LPA regulations (ZDS, 2007). The fat area is defined from the dorsal upper point of the muscle longissimus dorsi, where a perpendicular is dropped to the rind.

The carcass length was evaluated on the hanging half. It was measured from the cranial edge of the first cervical vertebra to the cranial edge of the pubic symphysis (ZDS, 2007).

Data analysis

The data analysis between breeds and within one breed at different time points was done by a one way ANOVA (post hoc test: Dunn's Method, Holm-Sidak method) using Sigma Plot 11.0 (Systat Software GmbH, Erkrath, Germany). The level of significance was $p < 0.05$.

All data were analyzed by means of statistical analysis using REML in the MIXED model procedure in SAS (SAS Institute Inc., Cary, NC, USA). Repetitive Variable is the time when the individuals are constant (piglets). The level of significance is $p < 0.05$.

Results

Data of the weaning period

The pure bred Turopolje (T x T) had black patches and clearly visible bristles. The skin of the crossbreed L x T was without pigments like L x P, but they had more visible bristles than L x P.

The T x T breed had 7 ± 1 SEM piglets per litter with a birth of weight 1.3052 kg ± 0.0937 SEM. The birth weight was significantly different ($p = 0.001$) between the litters of the 3 Turopolje sows. 4.3% of the T x T piglets was lost until the end of the fattening period. The greatest number of piglets was obtained by the L x T breed with an average of 15.3 ± 2.7 SEM per litter. One German Landrace sow had an unusually large litter of 18 piglets, although six piglets died during birth. Therefore, the mortality rate was higher than in the T x T and L x P breeds (T x T = 4.3%; L x T = 23.9%; L x P = 21.6%). Nevertheless, L x T had the highest birth weight of all breeds (1.3335 kg ± 0.0509 SEM). The average litter size of the L x P breed was 12.3 ± 0.25 SEM with a mean birth weight of 1.3286 kg ± 0.0446 SEM. The mortality was 21.6% until the end of the fattening period. The birth weight between the breeds was not significantly different ($p = 1.0$).

Feed intake

The daily feed intake of T x T and L x T was significantly higher compared to L x P. The significantly lowest daily gain ($p < 0.05$) had T x T compared to L x T, which had the highest daily gain. The intermediate daily gain of L x P was not significant to the two other breeds. The feed intake per kg gain was significantly different between all breeds ($p < 0.05$), while T x T had the greatest and L x P the lowest feed intake per kg gain. The same proportion was found for feed intake per kg carcass (Table 1).

Table 1. Mean values of feed intake, daily gain, feed intake/daily gain and feed intake/carcass ± SEM until week 25. Different superscript letters show significant differences ($p < 0.05$) between breeds

Breed[1]	T x T	SEM	L x T	SEM	L x P	SEM
daily feed intake [kg]	1.23^{A}	0.032	1.19^{A}	0.042	0.98^{B}	0.041
daily gains [kg]	0.34^{A}	0.009	0.38^{B}	0.007	0.37^{AB}	0.011
feed intake/gain per kg [kg]	3.63^{A}	0.076	2.72^{B}	0.826	2.62^{C}	0.055
feed intake/ carcass [kg]	4.58^{A}	0.446	3.11^{B}	0.111	3.13^{AB}	0.075

[1]T x T = pure bred Turopolje (n = 15), L x T = German Landrace x Turopolje (n = 23), L x P = German Landrace x Pietrain (n = 19)

Weight gain during the fattening period

The living weight of L x T was not significantly different to the new breed on week 20 and 25, but it was shown that they were heavier on week 25 than new breed (L x T at week 20: 83.985 kg, week 25: 106.150 kg; L x P at week 20: 82.067 kg, week 25: 100.736 kg). The weight of L x T raised sharply during the last five fattening weeks. During the growth we recognized just by L x T significant difference ($p < 0.001$) (Data not showen).

Carcass data

Figure 1 shows the comparison of the carcass weight. It did not differ significantly between the breeds on week 20 (T x T 58.4 kg ± 1.75 SEM, L x T 60.4 kg ± 1.41 SEM, L x P 62.1 kg ± 1.87 SEM), but on week 25 the weight of L x T and L x P was significantly higher than of T x T ($p < 0.05$) (T x T 69.6 kg ± 0.95 SEM, L x T 83.5 kg ± 2.70 SEM, L x P 79.9 kg ± 3.74 SEM). There was no significant difference between L x T and L x P on week 25. The weight differences within all three breeds between week 20 and 25 were significant ($p < 0.05$).

The muscle thickness, fat thickness, muscle lean, conductance 24 h post mortem, pH after 45 min and 24 h post mortem in chop (pH_1-K, pH_{24}-K) and ham (pH_{24}-S) and carcass length were measured on week 20 and 25. The water holding capacity and intramuscular fat was measured only on week 25 (Table 2 and 3).

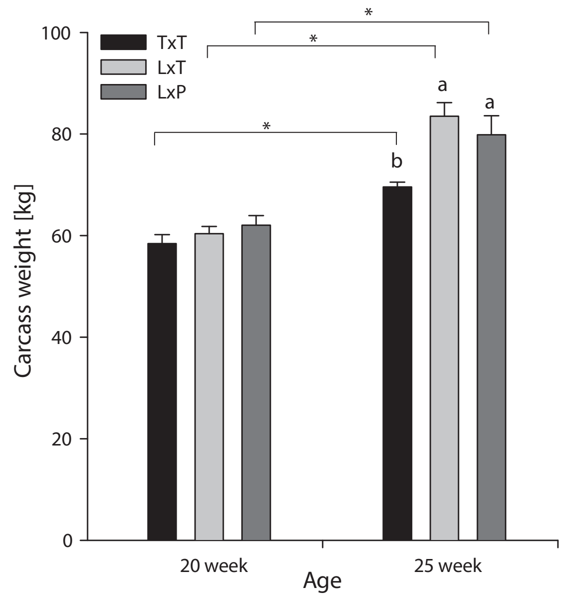

Figure 1. Carcass weight (kg ± SEM) on week 20 and 25. Different superscript letters show significant differences ($p < 0.05$) between breeds. Asterisk indicates significant differences ($p < 0.05$) between weeks within one breed

Table 2. Carcass data on week 20. Different superscript letters show significant differences ($p < 0.05$) between breeds

	T x T[1]	SEM[2]	L x T	SEM	L x P	SEM
muscle thickness [mm]	47.20^A	3.83	48.87^{AB}	2.08	58.08^B	1.03
fat thickness [mm]	29.29^A	1.65	16.40^A	1.43	9.16^B	0.57
muscle lean [%]	43.60^A	1.13	54.94^B	1.52	62.69^C	0.54
conductance 24 S[3] [mS]	3.81	0.58	2.94	0.42	2.91	0.48
conductance 24 SM[4] [mS]	6.67	0.74	5.46	0.73	5.51	0.81
pH_1-K[5]	6.10	0.12	6.13	0.06	6.11	0.06
pH_{24}-K[6]	5.47	0.01	5.41	0.00	5.48	0.02
pH_{24}-S[7]	5,47	0,00	5,46	0,01	5,66	0,07
carcass length [cm]	844,24^A	11,53	884,79^B	3,82	891,32^B	12,01
SEUROP class[8]	U-P		S-R		S	

[1]T x T = pure bred Turopolje (n = 8), L x T = German Landrace x Turopolje (n = 11), L x P = German Landrace x Pietrain (n = 9); [2]SEM = standard error of means; [3]S = ham; [4]SM = musculus semimembranosus (chop); [5]pH_1-K = pH 45 minutes post mortem of the chop; [6]pH_{24}-K = pH 24 h post mortem of the chop; [7]pH_{24}-S = pH 24 h post mortem of the ham; [8]SEUROP = German meat quality classification

Table 3. Carcass data on week 25. Different superscript letters show significant differences ($p < 0.05$) between breeds

	T x T[1]	SEM[2]	L x T	SEM	L x P	SEM
muscle thickness [mm]	46.00^A	2.08	57.17^B	3.63	64.69^B	2.27
fat thickness [mm]	31.60^A	2.51	24.07^B	2.76	11.53^B	0.83
muscle lean [%]	41.44^A	2.18	49.73^A	2.90	61.73^B	0.69
IMF[3] [%]	2.15^A	0.35	1.42^B	0.15	1.18^B	0.05
conductance 24 S[4] [mS]	4.48	0.62	3.56	0.38	4.51	0.55
conductance 24 SM[5] [mS]	5.19	0.65	5.56	0.70	6.30	0.50
pH_1-K[6]	5.99	0.07	6.20	0.09	6.22	0.10
pH_{24}-K[7]	5.59	0.02	5.88	0.01	6.26	0.00
pH_{24}-S[8]	5.79	0.04	6.04	0.02	6.24	0.02
carcass length [cm]	884.53^A	6.54	959.80^B	8.95	950.25^B	18.48
water holding capacity [%]	4.62	0.47	4.54	0.44	4.04	0.41
SEUROP class[9]	R-O		S-U		S	

[1]T x T = pure bred Turopolje (n = 7), L x T = German Landrace x Turopolje (n = 12), L x P = German Landrace x Pietrain (n = 10); [2]SEM = standard error of means; [3]IMF = intramuscular fat; [4]S = ham; [5]SM = musculus semimembranosus (chop); [6]pH_1-K = pH 45 minutes post mortem of the chop; [7]pH_{24}-K = pH 24 h post mortem of the chop: [8]pH_{24}-S = pH 24 h post mortem of the ham; [9]SEUROP = German meat quality classification

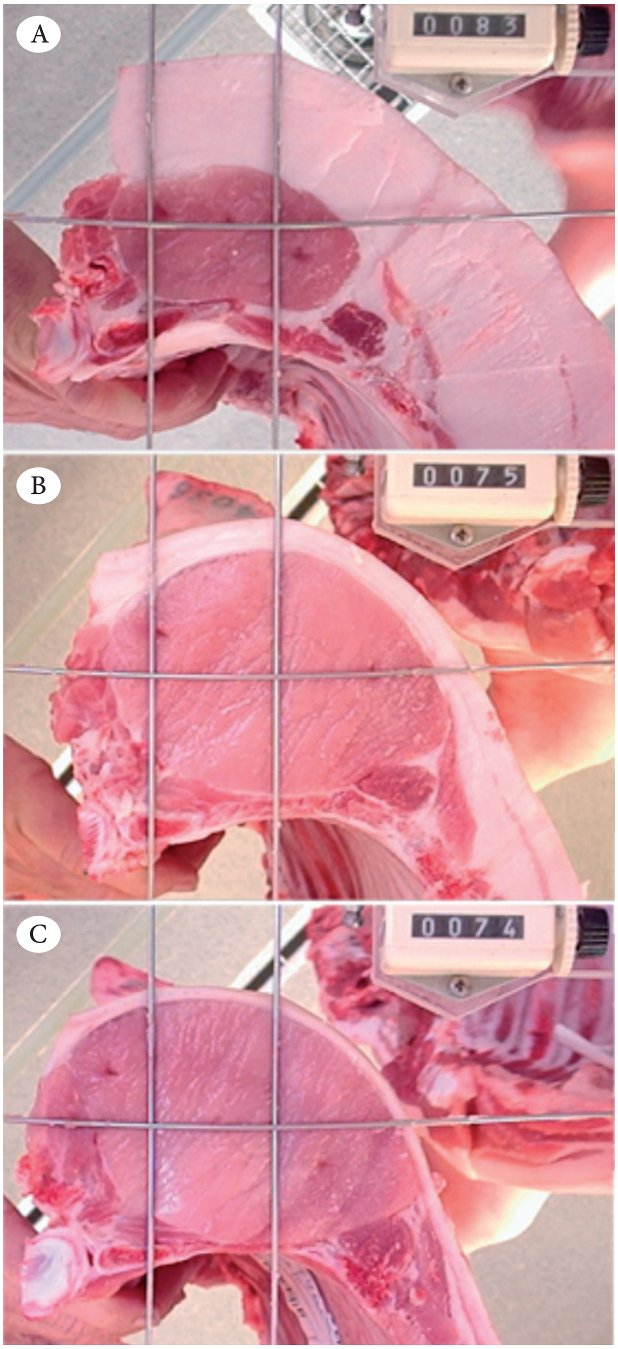

Figure 2. Measurement of the fat and meat area for all three breeds on week 25. A) TxT = pure bred Turopolje; B) LxT = German Landrace x Turopolje, C) LxP = German Landrace x Pietrain

The muscle area was greatest in L x P (46.2 qcm, 54.2 qcm) on week 20 and 25, respectively, immediately followed by L x T (35.0 qcm, 41.4 qcm). The difference on week 20 and 25 between L x P and L x T was not significant. The muscle area of T x T was smaller (21.7 qcm, 25.0 qcm) ($p < 0.001$) on both time points than L x P (Figure 2).

The muscle thickness was significantly lower in T x T than in L x P on week 20 and 25. It was neither significantly different in L x T to T x T nor L x P on week 20, but it was significantly greater than T x T on week 25.

The fat thickness on week 20 was lowest in L x P ($p < 0.001$) compared to L x T and T x T. The same trend was found on week 25, but the fat thickness of L x T was not significantly different to L x P.

L x P had the greatest muscle lean on both measurement points. All breeds were significantly different ($p < 0.05$) to each other on week 20, whereas on week 25 only L x P was significantly different to L x T and T x T ($p < 0.05$).

T x T showed the smallest carcass length on both measurement points ($p < 0.05$). The greatest length on week 20 had L x P with no significant difference to L x T. On week 25 L x T had the greatest carcass length ($p > 0.05$).

pH_1-K, pH_{24}-K, pH_{24}-S, conductance and water holding capacity showed no significant difference between the breeds.

IMF was measured on week 25 only. It was significantly higher ($p < 0.05$) in T x T compared to L x T and L x P. The IMF in L x T was by trend higher than in L x P.

Discussion

L x P is the standard fattening breed in Germany. It produces very lean but not very tasty meat. Lean meat is preferred in Germany (ZDS, 2007), but there are demands that the flavor should be increased. Therefore, the aim of the study was to evaluate the quality of the meat produced by German Landrace x Turopolje (L x T) on one hand and to evaluate the suitability of this breed for conventional fattening in an indoor system on the other hand. The Turopolje pig as old breed was chosen for its higher fat content. We hoped to increase the IMF in the crossbreed with German Landrace to get a more flavorful meat and to raise the interest on breeding Turopolje pigs, which is already an endangered breed (Đikić et al., 2010).

The Turopolje pig is normally bred outdoors in woods and marsh meadows with a restrictive feed input (Đikić et al., 2010). In Germany and Croatia exists no economically based program for using this breed or their crossbreed in production of dry cured meat as it is a usual practice for native breeds in Italy or Spain (Serra et al., 1998). One reason for that could be the small litter size per sow with an average of 6.67 - 8.56 piglets (Đikić et al., 1999). T x T had also the lowest litter size in our study. But interestingly the cross breeding of German Landrace sows and a Turopolje boar (L x T) resulted in the highest litter size, which might be due to the heterosis effect (Cecchinato et al., 2010). One sow had 18 piglets in one litter, but with 6 stillbirths. Therefore, the mortality rate was higher compared to T x T and L x P. Nevertheless, the total number of sows in all breeds was too small to achieve statistically evaluable data and should be increased in further studies. The birth weight for L x T showed no differences to L x P, but L x T received the highest living and carcass weight of all breeds.

Comparison of the feed intake between breeds

The daily feed intake was different between the breeds. T x T had the greatest intake followed by L x T and L x P. Recently, similar results were published by Acciaioli et al. (2002). They compared an Italian traditional breed Cinta Senese with Large White (modern breed) and the cross of the two breeds. The old race had a lower daily gain than the cross of the modern and old breed. The daily gain corresponds with our results. We also found that the ancient race T x T had the lowest and the crossbreed L x T the highest daily gain. The feed intake per kilogram gain of L x T was greater compared to L x P, but the feed intake per kilogram carcass weight was not different between these two breeds. It seems that L x T match the growth parameters of a modern hybrid pig like L x P. Interestingly, L x T grew the fastest between the first and the second slaughter point compared to the other breeds. As we expected T x T had the greatest fat thickness of all three breeds. In this study all breeds received the optimal feed mixture for the normally used hybrid pig (L x P), which is not optimal for T x T being adjusted from their origin to energy and protein poor fodder.

Comparison of the meat quality between breeds

In general, muscle thickness and lean meat were greatest by L x P. L x T showed a marginally less muscle thickness than the modern bred. The economic loss is not present. Lapp et al. (2009) researched the meat quality by pig with different rate of Duroc. The pigs without Duroc had a greater meat thickness than the pig with 25 or 50% Duroc rate (autochthon race). Furtheremore the IMF increased with the Duroc rate and the lean muscle decreased with the Duroc rate (Neudorf et al., 2013). In our study we show the same correlation: the higher Turopolje rate (autochthon race), the lower the meat thickness and lean muscle.

IMF, water holding capacity and conductivity values were selected criteria for more favorable meat quality. IMF is responsible for softness, initial tenderness and good consistency. The minimum of 1.5% IMF is required for a pleasant eating experience (Fortin et al., 2005). L x P did not achieve the desired value of 2% which is the threshold to achieve a good tasting meat in Germany. Some publications confirmed that the IMF is correlated with the sensory of the meat (Blanchard et al., 1999; Fernandez et al., 1999; Fischer et al., 2006; Wood et al., 2004). Ellis et al. (1996) and Serra et al. (1998) showed that there is a negative development of the IMF from old to new breeds and that crossbreeds have an intermediate IMF content. We found a similar result in our study. The old breed T x T had the highest IMF content, and the modern breed L x P the lowest. The IMF content in L x T reached nearly 1.5%, which is required for a pleasant eating experience.

Another important value describing meat quality is the water holding capacity. Drip loss is significantly influenced by stress resistance. The breed Pietrain has a low acceptance of stress in comparison to the other modern breeds, for example German Landrace or Large White (Dudenhoff et al., 2011). Genetic factors (Borchers et al., 2007; van Wijk et al., 2005), slaughter process and handling of the carcass (Huff-Lonergarn, 2002; Schellander et al., 2010) are essential factors for meat quality. The high water holding capacity also increases the weight of the meat and therefore increases the economical profit (Dudenhoff et al., 2011). Our results showed that the quality of the L x T meat in terms of water holding capacity was better than the L x P meat. The genetic parameters for the carcass composition of L x T will be an objective of a further study. Comparable results were shown by Lapp et al. (2009) using a crossbred between Duroc and German Landrace. They bred pigs with 25%, 50% and 75% parts of Duroc and showed that the meat with 75% part Duroc had the best quality. The same results were found by Jüngst and Tholen (2007) and Laube et al. (2000). The water holding capacity correlates with the conductance 24 h post mortem (Moerlein et al., 2007). The value of good quality meat is ≤ 7.8 after 24 h post mortem (Braun and Müller, 2006). In our study, L x T showed the lowest conductivity of all breeds on week 25. Moerlein et al. (2007) found similar results for a crossbreed with Duroc.

Conclusion

We were able to show that L x T achieved good breeding and fattening results in a conventional indoor breeding system. The meat quality was higher compared to the L x P meat, due to higher IMF, higher water capacity and lower conductance. L x T seems to have a better feed utilization, because of its lowest feed intake per carcass weight. Nevertheless, L x T should be fed more restrictive with a higher protein content to decrease the fat area and increase the muscle thickness at the end of the fattening period. Another possibility would be to breed German Landrace with 25% Turopolje and Pietrain (L x P with 25% T) and using the same fattening feed as for L x P. L x T might also be suitable for an extensive fattening system, because of its better growth and feed utilization. This should be analyzed in further outdoor and indoor studies with a feed lower in energy. The results of the crossbreeding of Turopolje pigs with a modern pig breed showed that the genetic diversity of this old race needs to be conserved and used in further breeding programs.

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